Attraction without distraction: Effects of augmented reality cues on driver hazard perception

Overview

Visual cues indicating the location of target stimuli have been shown to improve speed and accuracy of target detection (Berger, Henik, & Rafal, 2005; Luck & Vecera, 2002; Theeuwes, 1991a, 1994).

Augmentation can be used to highlight important objects or regions, superimpose informative annotations, or supplement a real environment. This technology has the potential to help attention impaired individuals accomplish difficult tasks such as driving by enhancing their perceptual abilities with information that is typically unavailable.

The following studies evaluated the effects of cue appearance and complexity incorporated into a set of scenarios to be used in a larger study investigating visual augmented reality cues that may potentially direct the attention of elderly useful field of view (UFOV) impaired drivers.

Pilot Study (Schall et al., 2010)

Introduction

This study evaluated effects of:
1) static visual cues (solid shape)
2) graded dynamic visual cues that converged around approaching targets

It was hypothesized that cues would reduce RT required to recognize potential hazards (e.g., pedestrians).

Methods

Six young drivers (Mean=25 years, SD=5; males=3, females=3) drove five simulated straight rural roadways under three conditions (static cued; dynamic cued; uncued).
- Dependent Variables:
  - RT of detection of potentially hazardous target event (90 trials)
  - Accuracy of detecting non-target (peripheral) objects (60 trials)

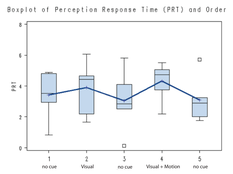
Results

- Main effect of condition on RT (sec) to perceive potential hazards (F(2,22)=6.02).

- No effect on periphery accuracy (F(2,22)=0.23).

- RT for uncued condition (Mean=3.18, SE=0.41) was faster than the static condition (Mean=4.79, SE=0.52, p = 0.002), but not different from the dynamic condition (Mean=3.44, SE=0.52, p = 0.59).

- The RT was lower for dynamic condition than static condition (p = 0.03).



Conclusions

Results did not show direct RT benefits for the tested AR cues. In fact, static AR cues increased RT for detecting hazards. This was likely due to local (lateral) masking or obstruction. AR cues did not impair perception of non-target objects in the periphery. The study was limited due to task simplicity and excessive cue salience. Gavin et al. (in preperation) addressed these limitations using a more difficult (dual) task and more ecologically congruent AR cues.

Expt. One (Gavin et al., in preparation)

Introduction

Using lessons learned from Schall et al. (2010), this study investigated improved visual cues and their ability to improve driver RT in a more complex driving situation.

We hypothesized that a graded dynamic visual cue which did not cause local masking would reduce driver RT for recognizing potential hazards.

Methods

Fifteen middle aged drivers (Mean=44 years, SD=5; males=7, females=8) drove six simulated straight rural roadways under four conditions (accurately cued; cued with false alarms (FAs); cued with misses; non-cued).
- Dependent Variables:
  - RT of detecting a potentially hazardous target event (108 trials)
  - Accuracy of detecting non-target (peripheral) objects (72 trials)
  - Driving difficulty was increased by including a lead vehicle following task

Results

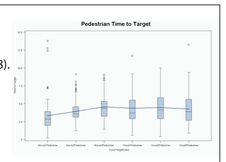
- Main effect of condition on RT (sec) to perceive pedestrians (F(5,63)=3.78).

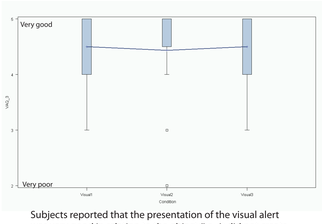
- No effect on periphery accuracy (F(5,63)=0.30).

- Time to target RT for the first uncued condition (Mean=3.39, SE=0.41) was smaller than the accurately cued condition (Mean=4.44, SE=0.41, p<0.01), the cued condition with misses (Mean=4.35, SE=0.42, p < 0.01), and the cued condition with FAs (Mean=4.63, SE=0.41, p < 0.01).

- Significant relationship between age and headway keeping ability (F(1,12)=15.45).

- Significant interaction between UFOV and condition for perceiving pedestrians (F(5,63)=2.39).

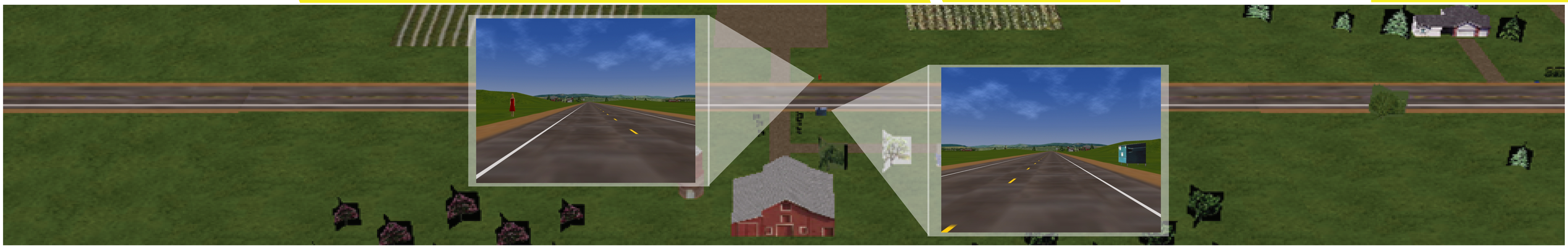




Subjects reported that the presentation of the visual alert was very good in relation to the object (i.e., it did not create obstruction as found in Schall et al. 2010).

Conclusions

Results showed a direct RT benefit for the tested AR cues when the search task involved detecting a pedestrian, but no benefits for vehicles or warning signs. This was likely due to salience, visibility, and/or size of the select target objects. AR cues did not impair perception of non-target objects in the periphery. The study was limited due to drive length and target characteristics. A follow up study is addressing these limitations using shorter scenarios and more equivalent targets.



Discussion

Highlighting cues may have influenced driver behavior. Increased vigilance may have been the result of the presence of the cue or general learning. The three limiting factors in detecting targets were:

1) Salience - In comparisom to vehicles and warning signs, the pedestrian was most difficult to see from a distance (Figure 1). The cue helped drivers to see it significantly sooner and thus they were able to respond sooner than in scenarios without visual cues (Figure 2).

2) Visibility - Most vehicles were visible before the cue appeared. In some cases subjects responded to them even before the cue showed up.

3) Size - The cue may have helped one to see the warning sign early, however the response was dependent upon discriminating the small shape on the sign (Figure 3). Therefore, making this judgment was usually consistently the same in both cued and non-cued scenarios.

Figure 1. Comparison of all target objects.

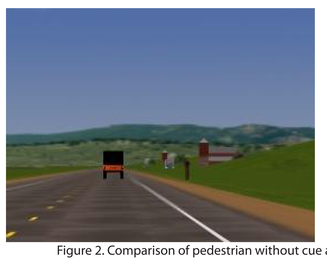


Figure 2. Comparison of pedestrian without cue and pedestrian with cue at same distance.

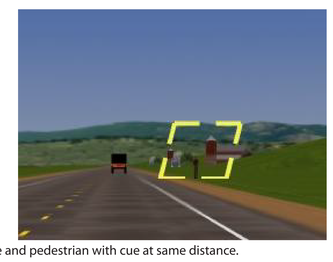


Figure 3. Comparison of warning signs in distance.

Future Work

Results from experiment one revealed potential changes for future work:

- Driving scenarios will be shortened to reduce simulator adaptation syndrome.

- Comparisons will be made between age groups (middle age and older) to assess the impact of age on cue effectiveness.

- Targets that did not benefit from the use of a visual cue for identification purposes (such as a vehicle) will be substituted for new targets that require earlier detection and attention.

- Multiple platforms will be used such as a miniature simulator and one with a motion based track.

- Multi-modal forms of attention such as haptic and auditory cues will be tested.

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